भारतीय मानक **IS 3972 (Part 2/Sec 2) : 2023**

Indian Standard

विट्रियस एनामेलवेयर — परीक्षण के तरीके

भाग 2 परीक्षण पद्धति

अनुभाग 2 कम और उच्च वोल्टेज परीक्षण के लिए दोष ढूँढना और अनुरेखण

(दूसरा पुनरीक्षण)

Vitreous Enamelware — Method of Test

Part 2 Test Methods

Section 2 Low and High Voltage Tests for Detecting and Locating Defects

(Second Revision)

ICS 25.220.50

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June 2023 **Price Group 5**

Ceramicware Sectional Committee, CHD 09

FOREWORD

This Indian Standard (Part 2/Sec 2) (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Ceramicware Sectional Committee had been approved by the Chemical Division Council.

The standard was originally published in 1968. In 1985, while reviewing IS 3972 : 1968, the Committee decided to publish it in two parts. Part 1 deals with production of specimen for testing and Part 2 deals with various test methods applicable to vitreous enamelled sheet, and vitreous enamelled cast iron. The Committee also decided that Part 2 shall have various sections and each section would deal with a particular test method.

This Part is published in several sections. The other sections of Part 2 are as follows:

Section 3 Resistance to boiling acids, boiling liquids, alkaline liquids and their vapours

Section 4 Resistance to thermal shock

Section 5 Resistance to hot alkali (sodium hydroxide)

Section 6 Reflectance and specular gloss

Section 8 Resistance to heat

Section 9 Resistance to dilute sulphuric acid at room temperature

Section 10 Resistance to hot detergent solution used for washing textiles

Section 11 Resistance to abrasion

Section 12 Resistance to torsion

Section 13 Resistance to warpage

In the second revision of this standard (Part 2/Sec 2) assistance has been derived from the following standards issued by International Organization for Standardization (ISO).

ISO 8289-1 : 2020 Vitreous and porcelain enamels — Low voltage test for detecting and locating defects — Part 1: Swab test for non-profiled surfaces.

ISO 8289-2 : 2019 Vitreous and porcelain enamels — Low voltage test for detecting and locating defects — Part 1: Slurry test for profiled surfaces.

ISO 2746 : 2015 Vitreous and porcelain enamels — High voltage test.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

In reporting the result of a test or analysis made in accordance with this standard, is to be rounded off, it shall be done in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’.

Indian Standard

METHODS OF TEST FOR VITREOUS ENAMELWARE

PART 2 TEST METHODS

SECTION 2 LOW AND HIGH VOLTAGE TESTS FOR DETECTING AND LOCATING DEFECTS

(Second Revision)

1 SCOPE

This standard prescribes the methods of test for detecting and locating defects in vitreous enamelled sheet steel and vitreous enamelled cast iron articles using a low and high voltage.

NOTES

1 The low voltage test is not intended as an alternative to high voltage test, but is a non-destructive test method for detecting defects which extend down to the metal base and weak spots in the enamel layer.

2 The purpose of the high voltage test is to detect and locate defects which extend down to the metal base, and weak spots in the enamel layer, that is, those areas of the enamel laver where its thickness falls below the required value determined by the application of high voltage, because of blisters, foreign body inclusions, spalling or cracks.

2 REFERENCES

The standards given below contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards:

IS No.	*Title*
IS 2717 : 1979	Glossary of terms relating to vitreous enamelware and ceramic — Metal systems (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2717, in addition to the following, shall apply.

3.1 Defects

Pores, tears, cracks or spalls, which penetrate to the base metal.

3.2 Weak Spots

Those areas of the enamel layer where its thickness falls below the required value determined by the application of high voltage, because of blisters, foreign body inclusions, spalling or cracks.

4 TEST SPECIMENS

The test specimens may be commercial items or parts thereof. No special preparation of the specimens is required.

5 LOW VOLTAGE TEST FOR DETECTING AND LOCATING DEFECTS

5.1 Principle

Testing is carried out at low voltage, contact being made with the defect by means of an electrolyte (conductive fluid). Readings indicating the presence of a fault may be made with an electrical measuring instrument or acoustically with headphones. Additionally, the defects may be made visible by colour effects.

5.2 Test Fluid

Dissolve (3 ± 0.1) g of sodium nitrite ($NaNO_2$) in 100 ml of water and add two drops of a liquid detergent. If the defects are to be made visible by means of a colour effect, add about 4 ml of 0.5 percent (m/m) phenolphthalein ethanolic solution.

5.3 Apparatus

5.3.1 *Power Source*

5.3.1.1 *Testing with direct current* — Use a 9 V battery, capable of being adjusted in the range 0 V to 9 V. A transistor radio battery 6 F 100 is suitable.

5.3.1.2 *Testing with alternating current* — An alternating voltage the amplitude of which can be infinitely adjusted between 0 V and the maximum

value about 5 V.

NOTE — The signal frequency superimposed on the alternating voltage lies within the audio range (600 Hz to 900 Hz).

5.4 Test Electrode

5.4.1 The test electrode consists of a plastics sponge, made of cellulose or similar material, soaked with the test fluid (**4.1**). Its size will depend on the desired accuracy of location and it is conductively connected, via a metal lead, to the positive pole of the apparatus.

5.4.2 For quick testing (coarse scanning) of large enamelled surfaces, test electrodes with an area up to 100 cm^2 are suitable; for the accurate location of defects, test electrodes with an, area of a maximum of 1 cm^2 are required.

NOTE — A large test electrode suitable for quick testing may also be used for locating defects-possibly using an increased sensitivity-if the enamelled surface is only touched by an edge of the test electrode.

5.5 Means of Indicating the Defects

5.5.1 If direct current is used, the current flow through the defects may be detected by means of a short circuit proof micro ammeter.

5.5.2 If alternating current is used, the current flowing through the defects may be detected as an acoustic signal by means of headphones. The intensity (sound level) of the signal depends on the magnitude of the current flowing through the defects. Other methods of indication may also be used.

5.6 Procedure

5.6.1 Connect the electrically conductive base metal of the article to be tested to one pole (negative in the case of direct current) of the power source (**5.3.1**).

5.6.2 Connect the test electrode (sponge) (**5.4**) to the other pole (positive in the case of direct current) of the power source (**5.3.1**). Soak the test electrode (**5.4**) in the test fluid until it is dripping wet and move it over the enamel surface at a speed not exceeding 0.2 m/s.

5.6.3 Start the test using a voltage around the mid-point of the selected range. Defects permit a current to flow whose magnitude depends on the area of the defect and the distance between the defect and the test electrode. Increase the voltage if no reading is obtained.

5.6.4 By varying the test voltage, the sensitivity of the test is adjusted so that when measuring with direct current, the pointer of the micro ammeter swings within the indicated range and when measuring with alternating voltage, the sound level is acceptable. (*see* NOTES given below **5.6.5**).

5.6.5 If it is intended to make the defects visible, ensure that a pool of the test fluid remains on the area under test or that the test specimen is wetted with the test fluid. When testing with direct current (**5.3.1.1**), an intense red colour will develop in the test fluid in the vicinity of the defects after about 3 s to 15 s.

NOTES

1 It is emphasized that it is not the magnitude of the reading that is of interest but its change due to the change in position of the test electrode.

2 Testing with alternating current (**5.3.1.2**), in addition to being more sensitive, enables the person carrying out the test to concentrate more fully on the article to be tested. Where there are numerous defects within the wetted testing area. However, the intensity (sound level) depends to a large extent on the distance of the test electrode from the neighbouring defect. It is therefore possible to locate defects which are not very far (10 mm and more) from large areas of defects (for example, at the rim).

5.7 Test Report

5.7.1 The test report shall include the following information:

a) Identification of the article tested;

b) The number and positions of defects; and

c) The description of the defects, where appropriate.

6 HIGH VOLTAGE TEST FOR DETECTING AND LOCATING DEFECTS

6.1 Principle

High voltage testing is carried out with dc voltage above 2 kV by passing a positive electrode over the enamel surface; the high voltage generator indicates defects and weak spots by a spark discharge and a simultaneous optical and/or acoustic signal.

6.2 Apparatus

6.2.1 *High Voltage Tester*

To deliver dc voltage above 2 kV corresponding to the testing voltage (**5.2.2**) and adjustable with the tolerances ± 5 percent. The total internal resistance shall be high enough to give the short-circuit current of the generator an arithmetical mean from 2 mA to 3 mA maximum. The peak value of the current during the spark discharge must be between 10 mA and 50 mA maximum an amount of charge

per impulse may be 25 µC maximum.

The negative pole of the generator shall be earthed and the positive pole shall be connected to the test electrode by a screened high voltage capable of suitable length.

6.2.2 *Test Electrode*

The test electrodes consist of an insulated hand piece and a brush holder made of metal wire for the test brush. The latter shall be constructed in such a way that it is completely unaffected by the spark discharge and shall be able to cover as large area as possible when sweeping the enamel surface. The hand-piece shall be provided externally with an earthed metal cover.

A protective resistor shall be arranged between the hand-piece and the test brush to limit the peak current value (10 mA to 50 mA maximum) during the electric spark discharge. This resistor shall be constructed in such a way that racking due to deposits of dirt reducing its value or the formation of an arc during the operation is not possible.

6.2.3 *Voltage Control and Indication of Defects and Weak Areas*

The test voltage shall be measured accurately to ± 5 percent directly behind the protective resistor of the hand-piece.

A device shall be provided which will give a clear option and/or acoustic signal at each spark discharge.

6.3 Procedure

6.3.1 The surface of the enamel layer under test shall be dry and free from impurities. The enamel layer shall have a temperature at 30 °C maximum. The metallic base material shall be earthed.

6.3.2 Apply the test voltage by taking into account end-use of the enamelled article, bearing in mind the dielectric strength and layer thickness of the enamel for an example as shown in Fig. 1. It shall amount to at least 1.5 times the break-down voltage for a layer of air of the same thickness.

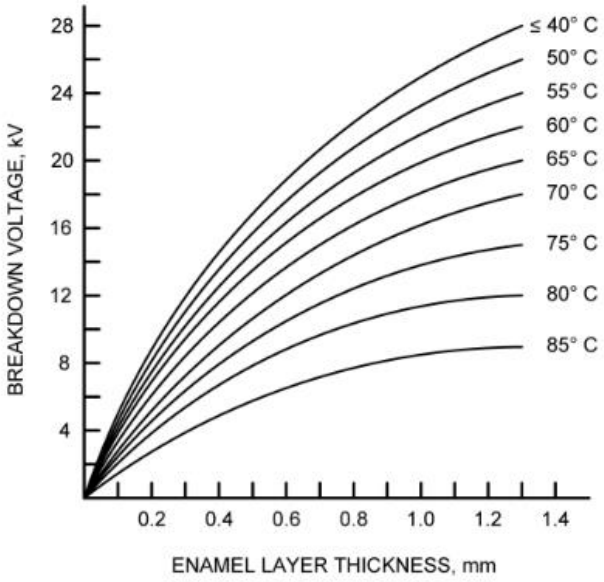


FIG. 1 BREAKDOWN VOLTAGE OF A SPECIAL ENAMEL, AS A FUNCTION OF A LAYER THICKNESS AND TEMPERATURE MEASURED WITH A SPHERICAL ELECTRODE

NOTE — The breakdown voltage of 1 mm air line between point and ball is approximately 1 kV.

6.3.3 Switch on the current, adjust the voltage to the test requirement and move the test brush covering an area as large as possible over the enamel surface at a speed of 40 cm/s maximum, controlling the voltage accordingly. If the voltage at the brush falls by more than 10 percent without a spark discharge occurring, investigate and remove the cause (*see* **6.3.1**). The schematic circuit diagram of D-C tester is given in Fig. 2.

Defects and weak spots are indicated by a visible spark and simultaneously by an optical and/or acoustic signal. Wherever a spark discharge occurs on the enamel surface it means a contact point and

indicates the position of a defect or weak spot.

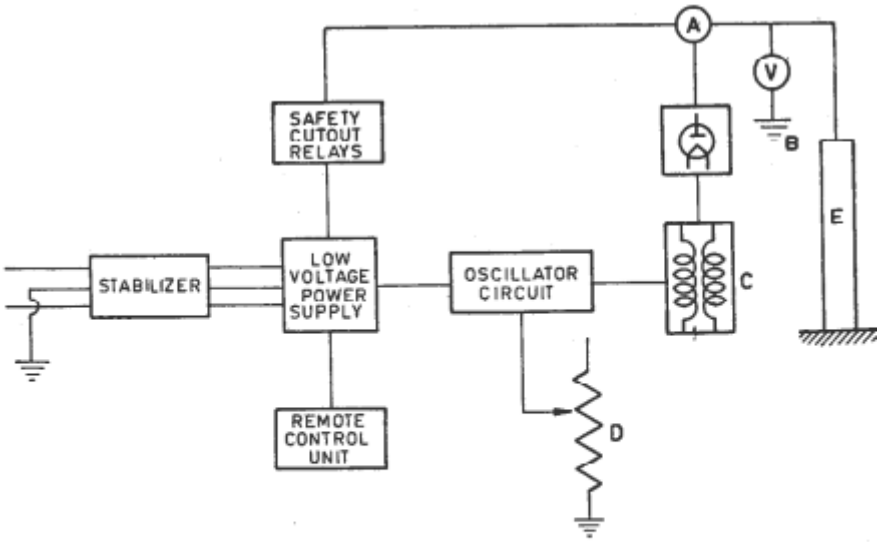
6.4 Report

The test report shall include the following particulars:

a) Test voltage;

b) Number and position of contact points; and

c) Thickness of the enamel layer where a defect (or defects) occurs.



A — Ammeter
B — High-Voltage Rectifier
C — High-Voltage Transformer
D — Voltage Control
E — Test Electrode
V — Voltmeter

FIG. 2 CIRCUIT DIAGRAM D-C TESTER

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Ceramicware Sectional Committee, CHD 09

Organization	*Representative(s)*
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This Indian Standard has been developed from Doc No.:CHD 09 (20620).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi